Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS)

D.R. Scott (Apollo 15). The apparent "haze" above the hills is caused by dust on the camera lens. (Courtesy of NASA)

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CU Partners:
Physics
Aerospace Engineering
Civil and Environmental Engineering
Astrophysical and Planetary Sciences

Institutional Partners:
NASA Johnson Space Center

Small Business Partners:
Tech-X Corporation
Zybek Advanced Products Inc.

International Partners:
MPI-E, Garching, Germany
MPI-K, Heidelberg, Germany
Institute for Space Systems, Stuttgart, Germany
Center for Plasma Astrophysics, Leuven, Belgium

The Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS) is focused on experimental investigations of the lunar surface, including dusty plasma and impact processes, the origin of the lunar atmosphere, and the development of new instrument concepts with a complementary program of education and community development. CCLDAS is an interdisciplinary program to address basic physical and applied lunar science questions, including issues important to ensure human safety and long-term usability of mechanical and optical devices on the Moon.

***Research on Surface Processes*:** The Moon's exposure to solar wind, UV radiation, magnetospheric plasmas, and meteoroid impacts, results in a complex, time-dependent environment, which creates a natural dusty plasma laboratory. The charging, possible subsequent mobilization, and transport of fine lunar dust (henceforth 'fines') have remained a controversial issue since the Apollo era, and have been suggested to lead to the formation of a 'dust exosphere.' CCLDAS is developing a series of laboratory experiments, supplemented by state-of-the-art theory and modeling, to determine: (1) the properties of the near-surface plasma environment, and (2) the charging of grains, the mobilization, lift-off, transport and adhesion. The results of these measurements will provide answers to open questions about the lunar surface and near surface environment, and new physical insights of high value to lunar exploration planners.

***Research on the Environmental Effects of Human and Robotic Activities*:** During the Apollo era the Moon proved to be a harsh living/working environment due to the copious amounts of dust liberated by human activity. It remains an engineering challenge to minimize the deposition and inhalation of lunar fines in/on space suits, rovers and habitats. The adhesion of lunar fines to exposed surfaces is largely due to their electrostatic charge from contact potential differences between various materials, and from frictional charge transfer or tribo-electricity. A series of laboratory experiments are dedicated to explore the role of material properties in determining the contact and tribo-electric charging of lunar dust, and to find the effects of UV and solar wind exposure on dust contamination. These experiments will provide a scientific basis for developing efficient dust hazard mitigation strategies.

***Research on New Instrument Concepts*:** CCLDAS laboratory experiments will directly lead to improved and tested tools for future in situ observations on the lunar surface. To characterize the near surface plasmas, fields, and dust environment we will focus on: (1) the best use of Langmuir and emissive plasma probes, and (2) the measurement of the mass, charge and velocity distributions of both the mobilized lunar soil and the impacting meteoroids. These instrument concepts are suitable for the International Lunar Network (ILN) landers under study by NASA/SMD as well as for the science done at the ESMD lunar outposts.

Facilities: Small-scale experiments (< 30 cm) involving UV and solar wind sources will be carried out in our existing Duane Dusty Plasma Laboratory (DDPL). Large (~ 1m) scale experiments on regolith mobilization will be done at the proposed Lunar Environment and Impact Laboratory (LEIL). LEIL will include a dust accelerator for micron-sized grains to generate high-velocity dust impacts, closely reproducing the effects of micrometeoroid impacts onto the lunar surface. Impact experiments will also be conducted at the existing Johnson Space Center Vertical and Light Gas Gun Facilities in order to extend the mass and velocity range of the impacting particles.

E/PO: CCLDAS will offer: (1) two professional development workshops for journalists nationwide, and (2) two public symposia at the University of Colorado, directed at our scientifically and technologically adept local audiences and offered through web-cast to the NLSI community.

Training: CCLDAS faculty will establish a new program in lunar science and exploration and build a strong undergraduate and graduate student community across departments and colleges. CCLDAS will establish a graduate certificate program in lunar physical sciences for students in the Physics, Astronomy and Planetary Sciences Department, as well as the College of Engineering. CCLDAS faculty will offer three new courses in lunar physical sciences and exploration to advanced undergraduate and graduate students: (1) *Introduction to dusty plasmas,* (2) *Instrumentation for in situ space measurements*, and (3) *Lunar surface laboratory experiments*.